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NGST Quarterly Review

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End-To-End Modeling Integrated Structural Model

24-June-97

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Sunshield Concept Development & Structural Modeling



Sunshield Concept Development & Modeling Status

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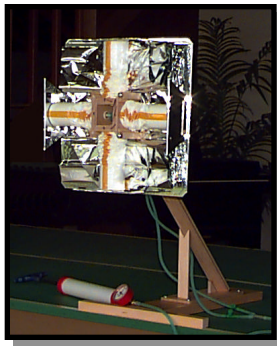
- ❑ Switched from 2 X 8 boom concept of Sept'96 to 1 X 4 boom concept that provides deployment control
- ❑ 4-Boom inflatable demonstration model completed
 - Deployed ~12 times to date with no failures (booms inflated ~25 times each) *Sometimes you get lucky*
 - No additional demo model work anticipated
- ❑ Sunshield dimensions revised to accommodate 4-beam deployment concept & to better match sunshield CP to Observatory CM
 - Area increased from 220 to 263 m²
- ❑ Generated preliminary mass, strength & stiffness sizing that appears compatible with both inflatable & mechanical-deployed booms
- ❑ Structural model consists of four beams with mass of all film layers distributed onto beams
 - A simple approximation – In reality, film layers & booms only hard-coupled at center of sunshield & ends of booms



Inflatable Sunshield Model Deployment Sequence

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Stowed
(0.3 m Square)



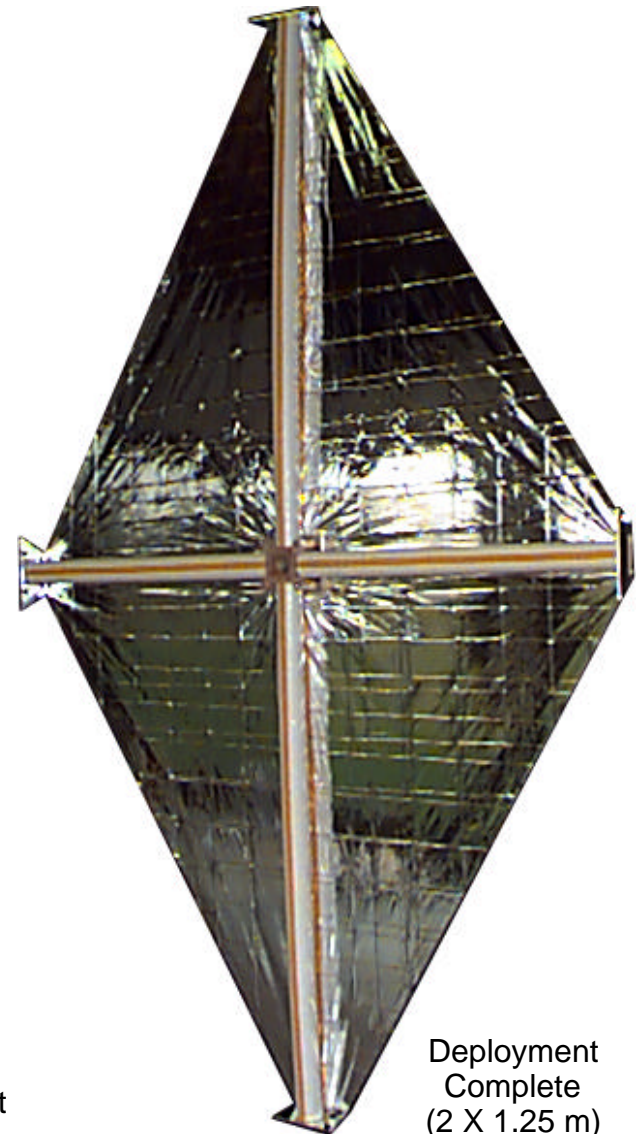
Vertical
Deployment



Vertical
Deployment
Complete



Horizontal
Deployment



Deployment
Complete
(2 X 1.25 m)

Note: So that the inflatable tubes can be seen, this demonstration is only with a single sunshield layer

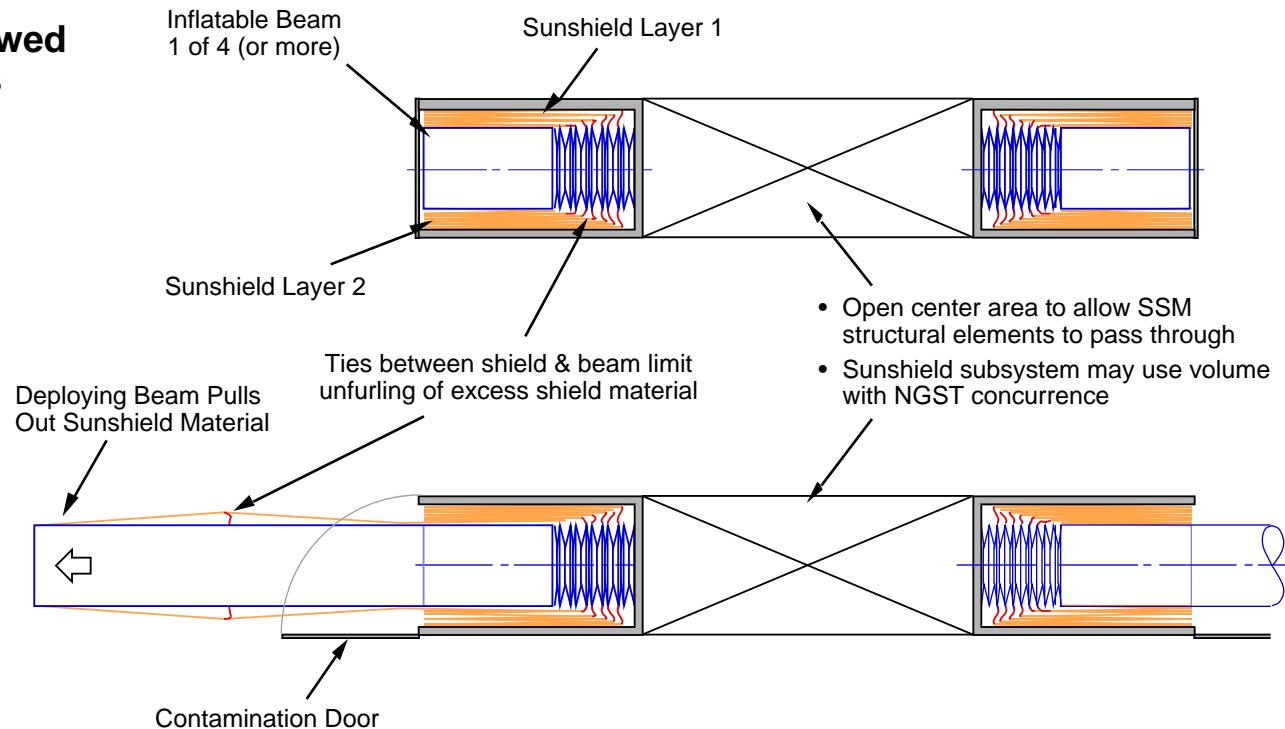


Sunshield Concept Utilizes Axial-Deployed Booms To Provide Deployment Control

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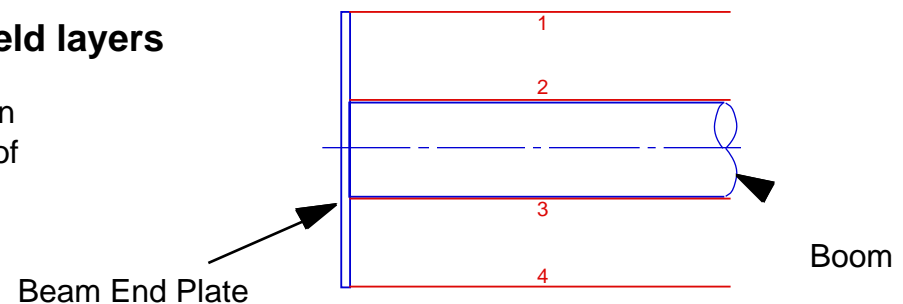
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☐ Concept meets stowed volume constraints



☐ One set of 4 booms deploys all four shield layers

Four booms of diameter $2D$ provide 4X increase in stiffness-to-mass ratio compared to eight booms of diameter D

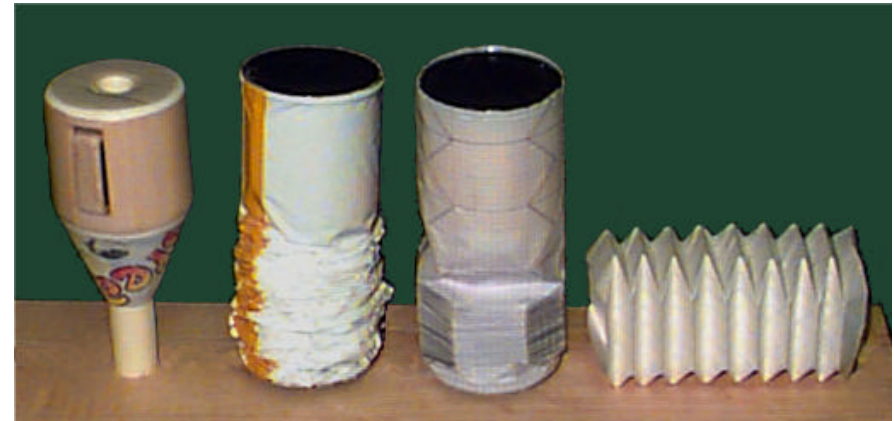
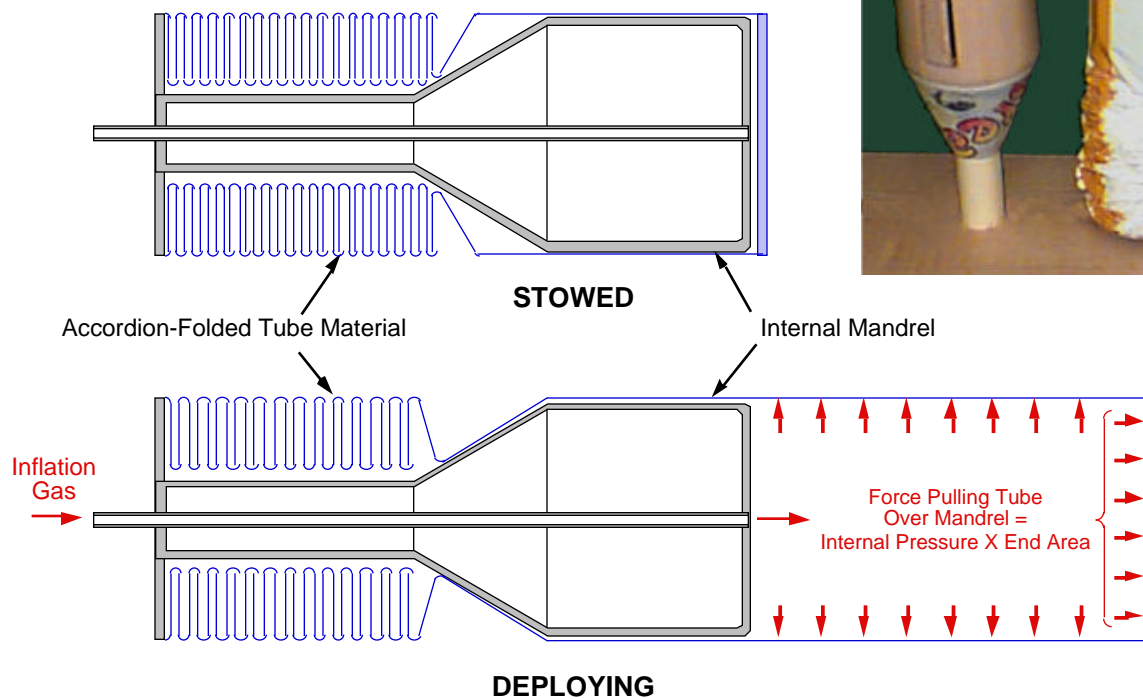




Sleeve-Over-Mandrel Inflatable Boom Provides Rigid & Straight Deployment

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- Internal pressure pulls folded tube material over mandrel
- Mandrel forces tube to unfold into cylindrical shape

- Mandrel guides tube in straight direction
- Internal pressure maintains shape of deployed tube



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Mechanically-Deployed Boom Study

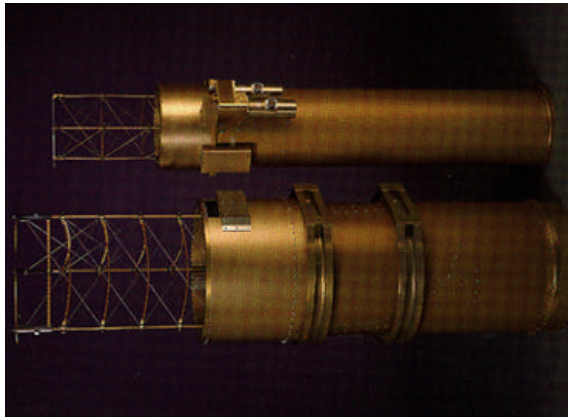
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- ☐ Have discussed sunshield concept with vendors (AEC-ABLE & Astro)
- ☐ Have tentatively selected nut-deployed continuous-longeron coilable lattice boom as substitute for inflatable boom
 - Best compromise between performance, cost & mass
 - Carousel-deployment a reduced cost, mass & size possibility if stiffness & strength during deployment can be shown to be adequate
- ☐ Have baselined mechanical-deployed booms for system mass estimate
 - TBD (<20 kg) associated with mechanical-deployed booms relative to inflatable booms
- ☐ Have suggested to vendors use of glass/carbon fiber composite longerons to increase stiffness
 - AEC-ABLE is interested & will pursue
- ☐ Based on preliminary spec, have requested ROM estimates of mass, size, performance & cost from vendors



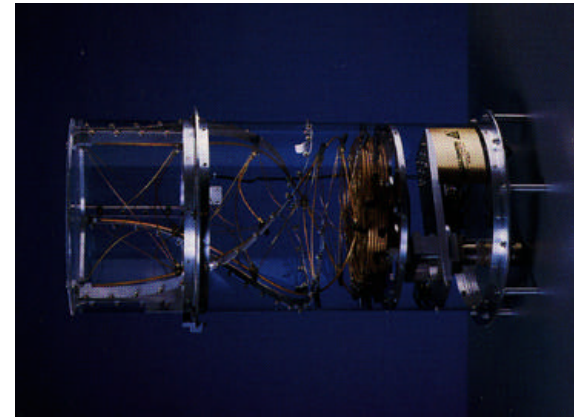
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Mechanically Deployed Boom Options NGST



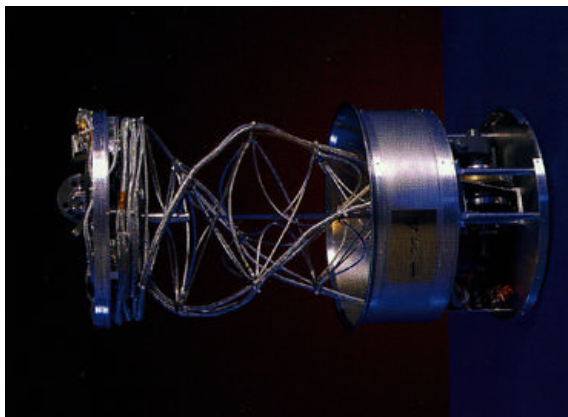
Nut-Deployed Coilable

- Motor-driven deployment; no boom twist; heaviest coilable design
- High strength & stiffness during deployment



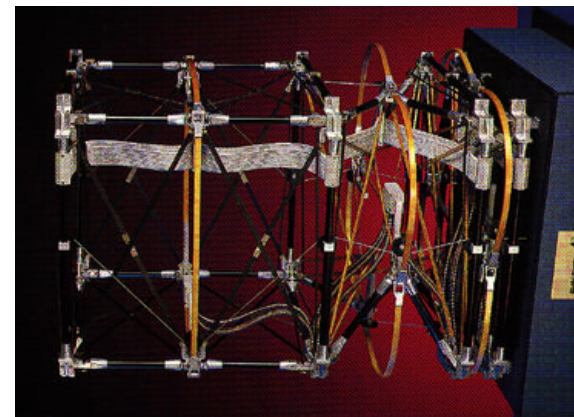
Carousel-Deployed Coilable

- Either self-deploying or motor driven; no boom twist
- Reduced stiffness & strength during deployment



Lanyard-Deployed Coilable

- Simplest design, but boom twists on deployment
- No appreciable strength or stiffness during deployment



Articulated-Longeron

- High stiffness & strength; variety of materials
- Increased mass, complexity & cost



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Future Plans Concerning Sunshield Development

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- ❑ Final report on sunshield preliminary concept by end of July
 - Awaiting vendor inputs on sizing & ROM cost estimate
 - Documenting numerous analyses made over last five months
- ❑ Hope to have sunshield QuickTime movie on NGST website by August
 - Discusses both inflatable & mechanical boom deployment
 - Includes demo model deployment sequence
- ❑ Want to further pursue sunshield dynamics characteristics using improved structural model including booms & film membranes
- ❑ Want to verify sunshield dimensions with regards to OTA shading over range of required pitch & yaw angles
- ❑ Investigate alternate sunshield accommodation concepts for alternate Observatory configurations
- ❑ Study new ideas from Technology Challenge Review as appropriate



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Integrated Structural Model

- ☐ **Model Simplification**
- ☐ **Model Changes**
- ☐ **Modal Analysis Results**



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Integrated Structural Model Development

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❑ Integrated model simplification

- Condensed SSM detailed model to single point mass with equivalent inertia
- Reduced Isolation Truss (~50 struts) to 4 equivalent beam elements
- Reduced Isolation Truss End Plate/ OTA Support Truss interface (~50 plate elements) to single equivalent 6-DOF spring element
- Result: Model reduced from 9K to 5K active DOF

❑ Integrated model modifications

- Changed Sunshield model from 16-boom to 4-boom design
- Changed OTA support truss from 8 struts to 6 struts (hexapod) with attachment points to OTA Main Ring at same points as SIM supports
- Increased number of grids on OTA Secondary Support Blades

❑ Enhancement of NASTRAN-to-IMOS model conversion

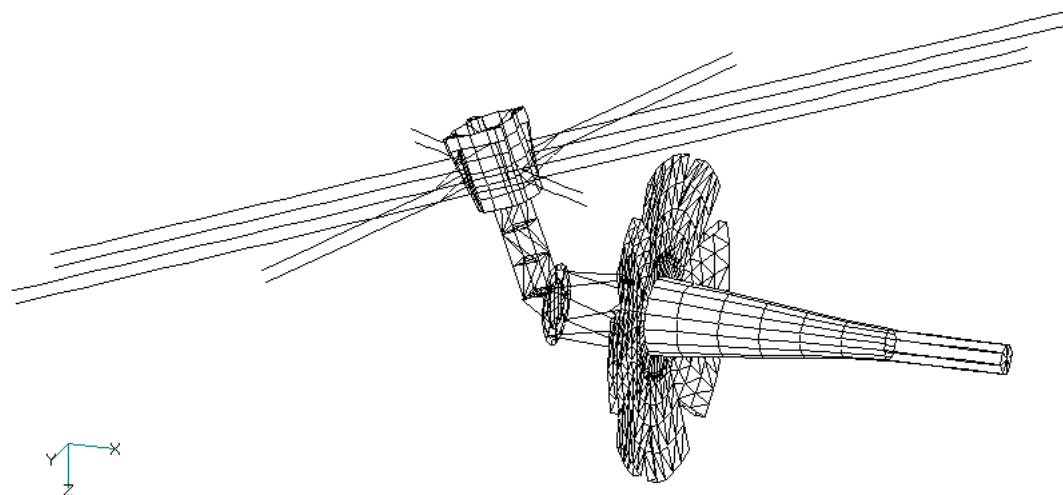
- Optimized rigid element processing with local coordinate system capability
- Automated thermal distortion analysis command sequence



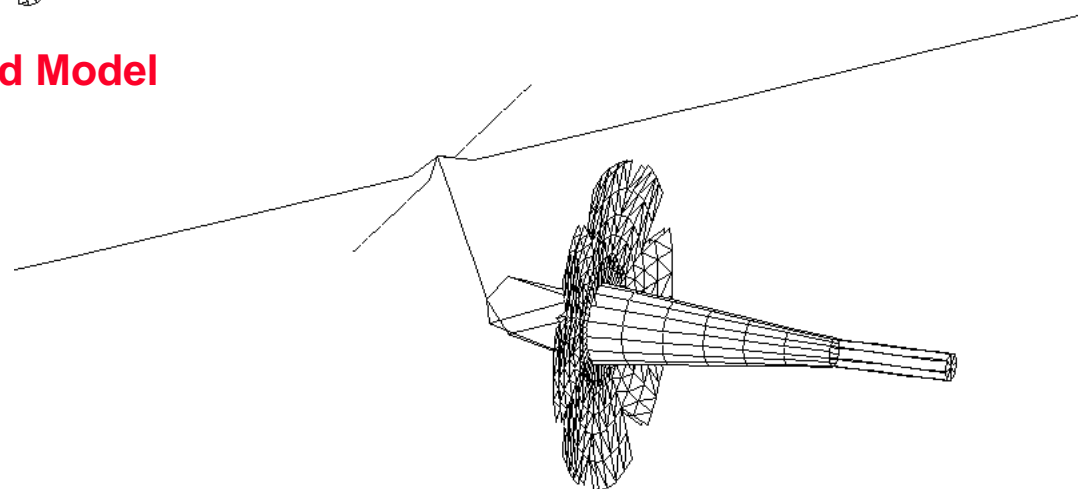
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Integrated Structural Models

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Sept'96 Detailed Model



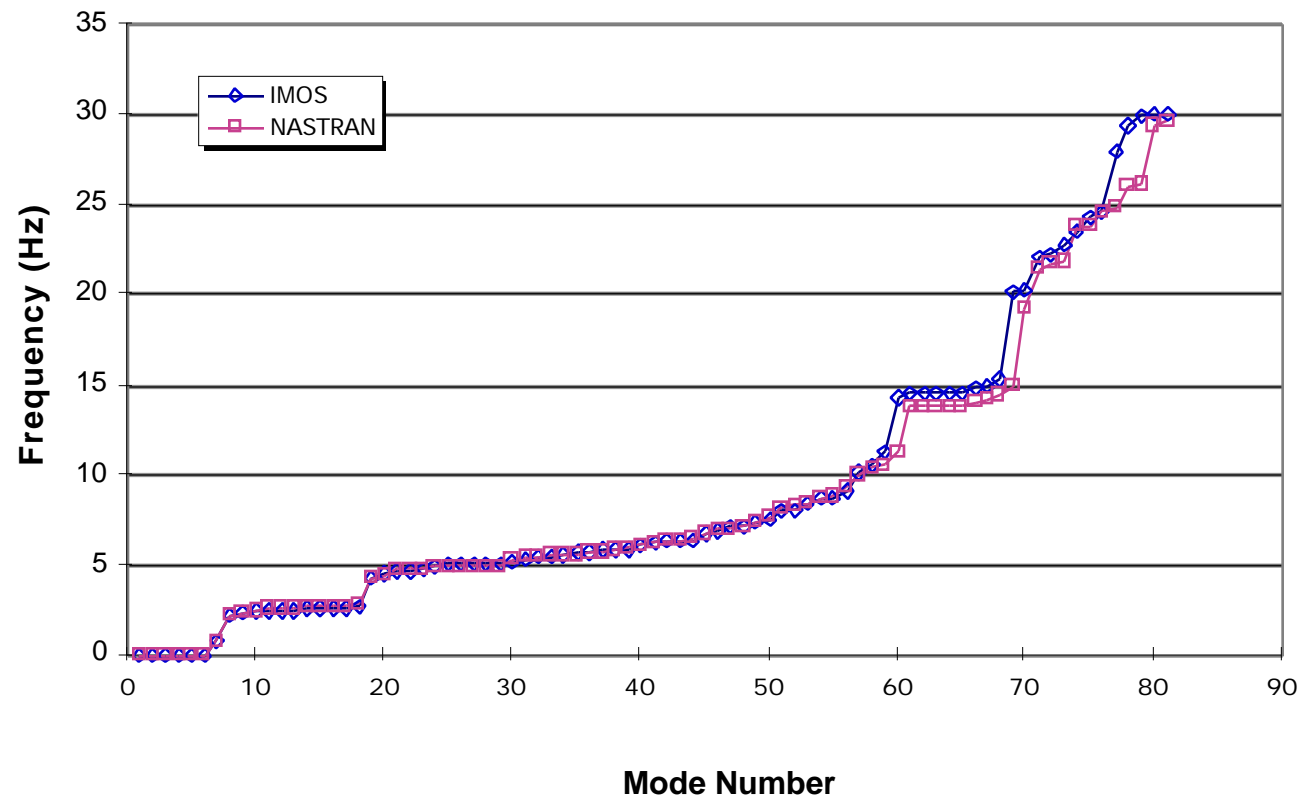
Current Reduced Model



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Comparison of Modal Frequencies for NASTRAN and IMOS Models

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Note that this figure is for comparison of IMOS & NASTRAN FEMs only and is not representative of the modal frequency distribution for the current FEM



Integrated Structural Model Normal Mode Description

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Mode No.	Freq (Hz)	Description of Mode	Mode No.	Freq (Hz)	Description of Mode
1	0	Rigid Body	26	4.91	Bending of Secondary Support Blades
2	0	Rigid Body	27	4.91	Bending of Secondary Support Blades
3	0	Rigid Body	28	4.91	Bending of Secondary Support Blades
4	0	Rigid Body	29	5.50	Lateral Translation of Secondary (Z)
5	0	Rigid Body	30	5.56	Torsion of Secondary
6	0	Rigid Body	31	5.58	Lateral Translation of Secondary (Y)
7	0.30	+X Sunshield Beam Bending; First Mode	32	7.10	Isolation Truss Bending (XZ)
8	0.32	+X Sunshield Beam Bending; First Mode	33	7.17	OTA Primary Petal Bending
9	0.51	-X Sunshield Beam Bending; First Mode	34	7.76	Isolation Truss Bending (YZ)
10	0.53	-X Sunshield Beam Bending; First Mode	35	7.87	OTA Primary Petal Bending
11	0.78	Torsion of Secondary	36	7.99	Isolation Truss Torsion & -X SS Beam
12	1.62	+X Sunshield Beam Bending; Second Mode	37	8.16	-X Sunshield Beam Bending; Third Mode
13	1.62	+X Sunshield Beam Bending; Second Mode	38	8.75	Isolation Truss & Primary Petals
14	2.01	±Y Sunshield Beam Bending; First Mode	39	8.77	Isolation Truss & Primary Petals
15	2.01	±Y Sunshield Beam Bending; First Mode	40	8.97	Isolation Truss, Primary Petals & +X SS
16	2.02	±Y Sunshield Beam Bending; First Mode	41	9.29	+X Sunshield Beam Bending; Fourth Mode
17	2.04	±Y Sunshield Beam Bending; First Mode	42	9.34	OTA Primary Petal Bending
18	2.81	-X Sunshield Beam Bending; Second Mode	43	9.59	Isolation Truss Torsion
19	2.81	-X Sunshield Beam Bending; Second Mode	44	10.15	OTA Primary Petal Bending
20	4.11	Lateral Translation of Secondary (Z)	45	11.40	Isolation Truss Bending (XZ)
21	4.46	Lateral Translation of Secondary (Y)	46	12.45	Isolation Truss Torsion
22	4.57	+X Sunshield Beam Bending; Third Mode	47	13.68	±Y Sunshield Beam Bending; Second Mode
23	4.57	+X Sunshield Beam Bending; Third Mode	48	13.69	±Y Sunshield Beam Bending; Second Mode
24	4.91	Bending of Secondary Support Blades	49	13.72	±Y Sunshield Beam Bending; Second Mode
25	4.91	Bending of Secondary Support Blades	50	14.01	±Y Sunshield Beam Bending; Second Mode



Integrated Structural Model Modal Frequency Distribution

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